AIRCRAFT MAINTENANCE ENGINEER TRAINING SYLLABI

Globally, the knowledge and skills required to maintain aircraft and aircraft components have been documented by bodies responsible for international [training] standards.

Based on "*international training standards*" promulgated by the *International Civil Aviation Organisation* (ICAO) in their Annex 1 Chapter 4 referenced training manual, the following mechanical syllabi adopts the referenced *Aircraft Maintenance Engineer* (AME) training standards that meets Australia's obligation under Article 37 of the Convention.

> *"8.7.6.3 The competence of maintenance personnel shall be established in accordance with a procedure and to a* ***level acceptable to the State*** *granting the approval."*

Article 37 of the Convention and these Annexes' provisions gives CASA the right to promulgate the ICAO international AME training standards syllabi. In addition, it has the right to state the syllabi pathway, based on the ICAO training manual, for an applicant to meet prior to applying for each CASA licence.

> ***ICAO Doc 7192 Part D1****. For this reason, the syllabi of instruction for the training of AMEs should be developed based on the specifications outlined in Chapters 2 to 13 of this manual. (Chap 4, can be pre-employment, Chap 3 LAME specific, Chap 5-12 AME.)*

The avionics trade level syllabi is based on Chapters 7, 8 & 12 and the mechanical syllabi is based on Chapters 5, 6, 10 & 11. Chapter 3 syllabi needs to be achieved to obtain an AME licence.

These syllabi are trade specific training standards and are underpinned by the general syllabi for all AMEs specified in Chapters 4 & 9. Chapter 4 relates to the Natural Sciences and should be the entry standard to trade training mentioned above, and Chapter 9 relates to Human Factors associated with trade levels.

The government has allocated Annexes 1, 6 & 8 compliance to CASA. However, within those Annexes, the government has also made the Education Department responsible for providing competencies and "qualifications" under the NVET system. Therefore CASA's important input is to promulgate these "international training standards" so the Education Department has an aviation regulatory input when providing competencies and qualifications.

CASA's role is to promulgate the Annex 1 "standards" – it is not CASA's role to be liable for the Education Department's responsibility to develop training packages that underpin AME academic "qualifications" that is the responsibility of the Education Department's Aerospace Industry Reference Committee. These "qualification" will be seen as internationally equivalent if the services of ***Trades Recognition Australia*** are used.

> The Education Department's "Trade Recognition Australia": "*Trades Recognition Australia (TRA) is a* ***skills assessment service provider specialising in assessments for people with trade skills gained overseas or in Australia****, for the purpose of migration and skills recognition*."

This Federal government has committed to funding AME apprenticeship training to the ICAO international training standard. This funding is needed to support RTO's providing the training. The majority of State funding comes from the Federal Government for vocational training. Some States have additional funding but they will not fund this training alone.

Without AME training standards, we end up in the mess we have today. Trade training must be broader than an AME licence scope to provide flexible transportable skills and qualification.

Doc 7291 Part D1, Chapters 5/6/10/11 Syllabi. AME Mechanical Trade Skills

Knowledge & Practical Training Underpinning B2 Licence

5.3. Maintenance Practices and Materials: Airframe/Powerplant

5.3.1. Aircraft, hangar and workshop safety precautions

- A guide to the various aspects of safe working practices, including the precautions to be taken when working with electricity, gases, oils and chemicals
- Instruction in the remedial action to be taken in the event of an accident with one or more of the hazards

5.3.2. Principles of workshop practice

- Care of tools; Use of workshop materials; Dimensions and standards of workmanship

5.3.3. General purpose tools

- Review of types of tools: hammers and mallets, screwdrivers, wrenches (spanners), torque wrenches, punches, pliers, clamps/vices/presses, hacksaws, snips/ nibblers, chisels, files, taps and dies, reamers, drill bits, thread gauges and crimping tools, grease guns, oil cans and lubrication methods

5.3.4. General purpose power tools

- Electric and pneumatic powered saws, drills, grinders, sanders, routers, nibblers, rivet guns and heat guns

5.3.5. Precision measuring tools

- Micrometers: metric/inch, vernier gauge, vernier calipers, surface table and accessories, marking out, dial test indicators, go/no-go gauges, combination sets, bore and depth gauges, steel rule, inside and outside calipers, slip gauges and feeler gauges

5.3.6. Screw threads

- Screw nomenclature
- Thread forms, dimensions and tolerances for standard threads used in aircraft
- Measuring screw threads

5.3.7. Bolts, studs, screws and fasteners

- Bolt types: specification, identification and marking of aircraft bolts, Society of Automotive Engineers (SAE) and metric
- Nuts: self-locking, anchor, and standard types
- Machine screws: aircraft specifications
- Studs: types and uses, insertion and removal
- Woodscrews, cotter pins, dowels, self-tapping screws and nuts
- Locking devices: tab and spring washers, locking plates, split pins, pal-nuts, wire locking, quick release fasteners, keys and circlips

5.3.8. Fits and clearances

- Allowances and tolerances, drill sizes for bolt holes, and classes of fits
- Common system of fits and clearances
- Schedule of fits and clearances for aircraft and engines
- Limits for bow, twist and wear
- Standard methods for checking shafts, bearings and other parts

5.3.9. Maintenance data, engineering drawings and diagrams

- Understanding of the following drawing types and diagrams, their symbols, dimensions and tolerances:
- Orthographic; isometric; oblique; perspective; electrical; block; schematic; sectional; blueprint; logic flow chart

- Identification of the following information within the title block:
  - drawing and revision number; reference number; scale; weight
- Understanding of the use of maintenance data to Specifications 100 and 2100 of the Air Transport Association (ATA) of America

5.3.10. Electrical cables and connectors

- Electrical connector: identification, codes, shape, locking pins, removal, insertion, crimping and soldering
- Electric cables: types, sizes, gauges, insulation, properties application, temperature ranges, numbering and identification
- Coaxial cables, high and low tension cables and precautions when attaching them
- Crimping, terminal ends, splices, wire grip, insulation grip, diamond grip, tools, colour codes, crimp insulation dimple codes tool testing, millivolt drop test, and go/no-go gauges

5.3.11. Aircraft fasteners

- Types of riveted joints, rivet spacing, and pitch
- Types of solid rivets: specifications and identification
- Types of hollow rivets: cherry, pop, chobert, avdel and semi-pierced
- Tools used for riveting and dimpling
- Inspection of rivets

5.3.12. Pipes and unions

- Identification of types of rigid and flexible pipes and their connectors that are used in aircraft
- Bending and belling/flaring aircraft pipes
- Standard unions for aircraft hydraulic, fuel, oil, pneumatic and air system pipes
- Inspection and testing of aircraft pipes and hoses

5.3.13. Springs

- Types of springs, materials, applications, limitations, inspection and testing

5.3.14. Bearings

- Purpose of bearings, loads, material, construction and application
- Types of bearing: plain, ball, roller, needle, self- aligning and air bearing
- Testing, cleaning and inspection of bearings
- Lubrication requirements of bearings
- Defects in bearings and their causes: brinelling, burnishing, galling, spalling, abrasion, burning, burring, chafing, chipping, corrosion, fretting, gouging, grooving, cutting, inclusions; nicks, peening, pitting and scoring

5.3.15. Gears

- Gear types: spur, helical, bevel, hypoid, worm, planetary, differential, sector, rack and pinion
- Gear ratios, reduction and multiplication gear systems, driven and driving gears, idler gears, and mesh patterns
- Inspection of gears, backlash and lubrication

5.3.16. Transmission systems

- Belts and pulleys, Bowden cables, and chains and sprockets
- Aircraft flexible control systems
- Screw jacks, lever devices, and push-pull rod systems

5.3.17. Cables and wires used in aircraft

- Standard wire gauges: British, American and metric
- Types of wire used on aircraft and specification for aircraft wire ropes
- Splicing and swaging of end fittings and types of end fittings
- Turnbuckles and standard tensioning devices, pulleys and cable system components
- Inspection and testing of flying control cables

5.3.18. Sheet metal work

- Marking out of sheet metal
- Calculation of bending allowance
- Folding, bending, forming, stretching, shrinking, shearing and riveting of sheet metal

5.3.19. Machine tool operation

- General understanding of operation of lathes, grinders, milling machines, shapers, scrapers, drills and saws (band)

5.3.20. Forging, welding, brazing, soldering and bonding

- Forging: hand forging of simple items, hardening and tempering of carbon steel using forge
- Welding: gas welding and brazing

- Electric arc welding: metallic arc welding, tungsten inert gas arc welding (TIG), atomic hydrogen arc welding, carbon arc welding, and metal inert gas arc welding (MIG)
- Resistance welding and spot welding
- Identification of welding defects, bad depth and width, penetration, undercut and spatter
- Soldering: soft soldering, hard soldering, silver soldering, flux, tinning, lead/tin content, melting points, and cold/dry joints
- Use of heat sinks
- Soldering iron types, temperature controlled and bits
- Bonding: resin bonding and adhesives

5.3.21. Aircraft materials: Ferrous

- Iron and steel production, strength, and melting points
- Characteristics of low, medium and high carbon steels
- Identification of common steels used in aircraft by SAE number
- Characteristics of various alloy steels
- Heat treatment, properties and application of carbon/ alloy steels
- Testing of ferrous materials for hardness, tensile strength, fatigue strength and impact resistance
- Electrical/magnetic properties of the material

5.3.22. Aircraft materials: Non-ferrous

- Aluminium, magnesium, brass, bronze, copper, lead, tin, zinc and titanium: production, weight, strength, melting points, heat treatment, anodic treatment, plating, applications and limitations
- Common alloying elements for magnesium and aluminium and the effect on the base metal
- Identification of heat treatment of aluminium alloys by code number
- Testing of non-ferrous metal for hardness, tensile strength, fatigue strength and impact resistance
- Electrical/magnetic properties of the material

5.3.23. Aircraft materials: Composite/Non-metallic

- Wood: types, specifications, plywoods, damage/failure mode, environmental contamination, disease, joining, cutting, grain, protection, sealing, application and uses
- Identification of composite materials commonly used in non-structural aircraft applications: glass, carbon, and kevlar fibres
- Standard weaves used in fibre mats and properties of fibre elements
- Resin matrixes and their properties
- Core material used in sandwich-type construction
- Defects in non-structural composite material; its detection and rectification
- Repair of laminates and fibre reinforced plastics, tools, testing, and vacuum processes
- Plastics, transparent materials, acrylics, glass and wood
- Sealants, bonding agents, rubbers, synthetic rubbers, characteristics, handling precautions, vulcanizing and inspection
- Electrical properties of the material
- Fabric covering, dopes, thinners, paints, cements, stitching, nails, tapes, patches, zips, and inspection panels

5.3.24. Corrosion

- Formation by galvanic action process, microbial and stress
- Types of corrosion: surface, intergranular, pitting, filiform and exfoliation
- Causes of corrosion: dissimilar metals, heat treatment, welding, fretting and stress
- Material types susceptibility to corrosion
- Identification of corrosion types, forms and effect

5.3.25. Aircraft corrosion control

- Methods of corrosion removal from common aircraft metals
- Corrosion protection treatment methods: chemical, sacrificial and mechanical
- Mercury contamination of aircraft structure, removal, protection and precautions

5.3.26. Non-destructive testing (NDT)/Non-destructive inspection (NDI)

- Dye/chemical penetrant method: water washable, post emulsifiable and solvent removable
- Magnetic particle, eddy current, conductivity and ultrasonic
- Radiographic X-ray/gamma ray
- Use of ultraviolet light with fluorescent dyes
- Methods for testing, castings, forgings, extrusions, welds aircraft and engine components
- Visual probes and eyeglass equipment

5.3.27. Basic electricity

- Use of electricity in aircraft
- Elementary electrical physics: types of electricity
- Units: amps, ohms, volts, watts, and Ohm's Law
- Mechanical and chemical methods of producing electricity

5.3.28. Aircraft handling

- Aircraft towing: safety precautions, towing arms, weak links, locking devices, weight limits, turning angle limits, control of aircraft brakes, lookouts, tugs and tractors
- Aircraft jacking: principles of aircraft jacking, safety precautions, weight and balance limits, jack types, jacking points and jacking techniques

5.4. Systems and Structures: Fixed Wing	5.5. Systems and Structures: Rotary Wing
5.4.1. Mechanical control components: Construction and function • Function and adjustment (where applicable) of bell cranks, quadrants, levers, torque arms, torque tubes, push-pull rods and their end fittings, universal joints, fire and vapour seals for control systems • Function, inspection, maintenance and identification of cables, cable end fittings, pulleys, cable guards, and cable tensioning devices • Chains and sprockets: types, construction, distortion, wear, elongation, and prevention against jamming	**5.5.1. Main rotor heads (MRH)** • Main rotor head: various designs and features to accommodate flapping, feathering, leading and lagging actions of main rotor blades • Operation of swash plate and its effect on tip path plane • Construction and operation of rotor blade dampers • Mounting, inspection and maintenance of main rotor heads
5.9. Fuselage, doors, engine mounts and landing: (Gear attachments) • Construction methods: truss (Pratt truss and Warren truss), monocoque and semi-monocoque (including the identification of load-carrying members) • Construction of doors, nacelles and firewalls • Engine mountings, pylons, and vibration damping • Landing gear and skid mounting attachment points • Winches, cables, supports, lifting hooks, and hard points • Flotation devices: explosive and mechanical activation	**5.5.2. Tail rotors and anti-torque control** • Methods of achieving directional/anti-torque control through tail rotor, bleed air or aerodynamics • Principles, construction, mounting and maintenance requirements of typical tail rotor drive systems (including shafts, bearings, couplings, universal joints, gearboxes and pitch change mechanisms)

5.4.2. Hydraulic system

- Principles of hydraulics: its relation to Pascal's Law, understanding of the relationship between pressure, force and area relating to differential areas, pressures and mechanical advantage
- Hydraulic fluids: types, identification, military specifications, colour, properties, user precautions, and applications
- Hydraulic seals: types, seal/fluid correct compatibility, identification, applications, tools, storage life, and maintenance practices
- Fittings and flexible pipes: identification of pipes, inspection and maintenance of pipes, and hydraulic accumulators
- Pumps: manual and power operated; reservoirs; filters; regulating valves; hydraulic fuses; priority systems
- Pressure/contents/temperature indication
- Interface with electrical and emergency systems
- Typical hydraulic systems in aircraft

5.4.3. Pneumatic and air systems • High-pressure air systems and components • Bleed air pneumatic systems • Safety precautions when working with high-pressure gas systems • Pneumatic control systems features, components and function • Inspection and maintenance of air/pneumatic systems	**5.5.3. Clutches, freewheel units and rotor brakes** • Operation, function, construction, and component location

• Ducting, mass flow, pressure control/indication, leak detection, valves, alternate supply, Auxiliary Power Unit (APU), and ground cart supply • Indications and system protection devices	
5.4.4. Airframe structures: General concepts • Airworthiness requirements for structural strength • Understanding of the following terms: • Strain; bending; compression; shear; torsion; tension; hoop stress • Understanding of the principles of "fail safe" design, fatigue life, strength and rigidity • Construction methods: monococque, semi-monococque and truss (Pratt truss and Warren truss) • Non-stressed skin fuselage construction and stressed skin fuselage construction • Formers, stringers, longerons, bulkheads, frames, struts, ties, beams, floor structures, reinforcement methods of skinning, anti-corrosive protection skin, wing and empennage attachments, doors, windows, nacelles, engine mounts, pylons, vibration damping methods, and firewalls	**5.5.4. Cyclic control system** • Operation and function of system • Layout and location of components (cyclic stick to pitch-change rod inclusive)
5.4.5. Wings, primary and auxiliary control surfaces • Wing construction methods: monospar, multispar, and box beam • Wood, metal and composite spars • Constructional features: ribs, struts, wires, tie rods, braces, stringers, stressed skin, and biplanes • Leading and trailing edges, and wing tips • Fuel tanks: integral and detachable, internal and external, sealing of fuel tanks and inspection of tanks • Load distribution on cantilever spar beams • Special construction methods: spot welding, adhesive bonding, honeycomb structures, integral milling, and contour etching • Constructional and general features of primary and auxiliary control surfaces • Static and aerodynamic balancing of control surfaces • Calculations for the balance of controls following repair or repainting • Trim and balance tabs, and mass balance	**5.5.5. Collective control system** • Operation and function of system • Layout and location of components (collective lever to pitch-change rod inclusive) • Pilot control for power and non-power assisted flying controls • Methods of rotor revolutions per minute (RPM) compensation applicable to collective control

5.4.6. Inspection of structures
• Understanding of the following terms:
  • fuselage station
  • wing station
  • water lines
  • butt lines or buttock lines
• ATA-100 zoning system used to identify aircraft component locations and access points
• Inspection of structures for wear, damage and deterioration
• Identification of visual indications of flight or ground overloads, structural failure of adjacent members and corrosion
• Classification of damage, repair or maintenance implications attributed to structures
	5.5.6. Main rotor gearbox and main rotor mast
	• Operation, function and mounting methods of gear-boxes and masts
	• Lubrication and loads
	• Inspection and maintenance of gearboxes and masts

5.4.7. Airframe symmetry • Methods of alignment and symmetry checks: wings	**5.5.7. Main/Tail rotor blades** • Construction methods and materials used in wood,

and horizontal stabilizers for dihedral and incidence; vertical stabilizers for alignment; fuselage for twist and bending, and complete airframe for symmetry • Understanding of the following terms as they are applied to airframe symmetry requirements: • Stress; rigging position; incidence angle; wash in; wash out; anhedral; dihedral; longitudinal dihedral; stagger; decolage; cabane struts; interplane struts	metal and composite main and tail rotor blades • Blade attachment systems • Inspection and maintenance of main and tail rotor blades

5.4.8. Fastener installation
• Identification of solid and blind rivets by head markings, physical characteristics and identification number
• Requirements for edge distance, pitch and gauge for rivet installation
• Identification of incorrectly installed rivets and rivet failure
• Understanding of the following terms in relation to rivet design, installation or layout:
  • pitch
  • gauge
  • clearance
  • dimpling
  • shaving
  • countersinking	

5.4.9. Sheet metal repair in aircraft • Understanding of the following processes used in the fabrication/repair of sheet metal parts: folding, bumping, dimpling, crimping, stretching, shrinking, joggling, coining operation and use of the hand and power tools such as shears, presses, brakes/folding machines, roll formers, cutters and guillotine • Calculation of bend allowance and setback • Calculation of geometric shapes: circumference of circles, length and angles of the sides of triangles, etc. • Calculation of weight of completed repair and determination of its effect on surrounding structure	
5.4.10. Tubular structure repair • Design characteristics: angles and dimensions of tubular weld repairs patching, inner and outer sleeves, and splicing • Typical non-welded repairs of tubular structural members	
5.4.11. Window and windshield repairs • Hot and cold methods of forming acrylic sheet • Considerations and precautions to be taken when cutting acrylic sheet • Cementing and curing of acrylic sheet • Finishing methods for acrylic sheet, buffing, polishing and cleaning • Glass windshields: construction, lamination, fitting, removal, handling, storage, inspection, heating, sealing, cleaning, and minor damage repair techniques	
5.4.12. Pressurized structures • Understanding of aircraft design related to load transfer, load path continuity and reduction of stress raisers in pressurized fuselages • Methods by which doors and other large cutouts are restrained from opening under pressurization loads • Methods used to seal structure and components to the structure of airframe pressure cells • Methods used to ensure structural protection from rapid decompression • Sealing methods at pressure bulkheads for control and electrical cables • Sealing methods used in doors and cutouts in pressure cells • Maintenance precautions in maintenance of blowout panels, airflow louvres, and decompression doors • Methods used to achieve minimum drag and aero-dynamically clean structures	**5.5.8. Blade tracking and helicopter vibration analysis** • Precautions to observe when moving and positioning helicopters (e.g. turning rotor blades) • Methods of and requirements for tracking main and tail rotor blades • Balancing, static and dynamics of main and tail rotor blades • Hub and main rotor alignment; checks and adjustment on semi-rigid rotor heads • Types of vibration experienced in helicopters: causes and effects • Methods used to reduce vibration and dampers • Auto-rotation: calculation of correct rotor speed and effects of too high or too low rotor RPM
5.14.13. Surface protection and paint systems • Methods for the removal of existing corrosion	

protection and surface corrosion • Methods of preparation, cleaning and degreasing prior to surface treatment • Methods of pre-treatment prior to application of finishes • Various types of primers; advantages, disadvantages and uses • Various types of topcoat finishes; advantages, disadvantages and uses • Physical conditions necessary for correct application of particular finishes: temperature, humidity, dust free, etc. • Application process and equipment including cleaning equipment after use, techniques of spraying, etc. • Identification and understanding of possible causes of defects in applied coatings or finishes	
5.4.14. Landing gear and associated systems • Fixed landing gear: tail wheel assemblies, nose wheel types, shock struts, shock or bungee cords, bracing, spring steel struts, air-oil oleo struts, spring-oleo struts, floats and skids • Retractable landing gear: geometry, construction, actuation, locking, position indication, torque links, drag braces and bogey beams • Limit vertical inertia load factor and energy dissipation rate • Tail wheel and nose wheel types, track-type gear, tandem and multi-contact gears, crosswind landing gear, anti-shimmy mechanisms, gear doors and mechanisms, and emergency extension • Nose wheel steering: principles, control, actuation, maintenance and inspection • Wheels and tyres: treads, size, construction, speed limits, identification/markings, pressures, valves, safety devices, inflation, inspection and maintenance • Brakes: braking factors, actuation, heat dissipation, anti-skid devices, disc brakes, drum brakes and expanding tube brakes • Auto-brakes, single and dual servo brakes, and master cylinders	
5.4.15. Ice and rain protection • Ice formation on aircraft, engines and propellers, its effects and classification • Anti-icing systems: electric, thermal and chemical • De-icing systems: electric, pneumatic and chemical sensors, and indicators for quantity or temperature cyclic systems • Chemical rain repellent systems • Pneumatic rain removal • Ice detection systems • Water and toilet drain heaters • Windshield wipers: electric and hydraulic • Demisting • Ground removal of frost, ice and snow: temperatures, time limits, materials and application techniques	
5.4.16. Cabin systems and installation • Water systems and pressure control	

• Safety installations: emergency exits, life jackets and dinghies, escape slides, harnesses and safety belts, seats and seat belts, freight stowage, and catering trolleys, and crash, rescue and first aid equipment • Operation of safety devices and control of service power supply (such as refrigeration, galleys, heaters and other cabin equipment including lift mechanisms) • Toilet and sanitary equipment including health precautions • Waste collection and drainage • Safety precautions related to emergency exits and escape slides • Cabin entertainment (films, video, television and audio) and public address • Furnishings, soundproofing, and role change equipment • Operation of internal and external, normal and emergency lighting systems	
5.4.17. Environmental, air conditioning and oxygen systems • Gas composition of the atmosphere and the physical properties of oxygen • Understanding of hypoxia, anoxia, hyperventilation and carbon monoxide poisoning, including related symptoms for each • Elements and principles of cabin air conditioning: power, air supply, cabin structure, pressure control, pneumatic and electronic control devices and sensors, safety and warning devices • Cooling and heating: air cycle machines, refrigeration equipment, vapour cycle systems and controls, electrical, exhaust and combustion heaters, temperature control equipment, and circulation systems • Humidity control: humidification, water separation, and humidity control devices • Oxygen systems: oxygen storage, distribution and production • System components: regulators (continuous flow, demand, diluter-demand and pressure-demand types), oxygen bottles, identification of oxygen equipment, demand valves, charging valves, quantity and pressure indication, pipes and connectors, masks, safety and pressure relief devices, liquid oxygen systems, gaseous oxygen systems, chemical oxygen systems, on-board oxygen generation systems, and purging method for oxygen systems • Safety precautions related to the handling and replenishment of oxygen systems • Testing of oxygen systems, pressure cabins and test equipment • Bleed air, turbo-charged bleed air, mass flow control, temperature control, differential pressure and maximum pressure	
5.4.18. Fire warning, protection and control systems • Aircraft and engine fire warning principles and	

control • Principles of fire and smoke warning and detection systems • Principles of fire extinguishers: extinguishing agents, types of extinguishers and their operation • Installation layout of typical fire warning and detection systems in aircraft and their operation • Awareness of life limitations of fire extinguisher components • Testing of fire warning/detection/extinguisher systems • Precautions to be taken during servicing and maintenance • Centralized warning systems, principles of inputs-outputs and priority philosophy	
5.4.19. Fuel supply systems • Layout of fuel supply system for piston- and turbine-powered aircraft • Non-return valves: refuelling/de-fuelling/fuel dump • Contents indication, instrument and electrical interface • Venting, tank sealing, and sealants • Identification and location of fuel system components • Water drains and testing for water contamination of fuel • Fuel-specific gravity, densitometer, and fuel properties • Usable/unusable fuel • Boost/scavenge systems • Use of fuel for aircraft trim control	
5.4.20. Aircraft electrical systems • Lead acid batteries: plate material, electrolyte, specific gravity, capacity and capacity testing, determination of state of charge, charging constant voltage/constant current, gassing, sulphation, temperature, hydrometer, and insulation and resistance (I/R) checks • Safety precautions when dealing with lead acid batteries • Neutralization of acid spills, cleaning and maintenance • Storage and shipping requirement • Environmental hazards associated with lead acid batteries • Separation of lead acid and nickel-cadmium battery: charging facilities, location, storage, components, chemicals and service equipment • Nickel-cadmium batteries: plate material, electrolyte, capacity and capacity testing, determination of state of charge, gassing, charging constant current, cell imbalance/balance, cell voltage reversal, I/R checks deep cycle recovery, cell removal/replacement, and cell leak tests • Thermal runaway: cause and prevention, temperature indication/warning and control • Neutralization of electrolyte spills, cleaning and maintenance • Storage and shipping requirements • DC power supplies: generators construction, function and maintenance, and generator balancing • Voltage regulators: carbon pile, mechanical, electronic, cut-outs, reverse current relays, and circuit protection • Typical DC circuits, DC motors and actuators • AC power supplies: alternators (single phase and three phase), inverters (static and rotary), transformers, rectifiers, transformer rectifier units, and protection devices • Alternator drives, constant speed devices, integrated drive generator systems, and data bus systems • Aircraft electrical wiring: cable specifications, looms, identification, fuses, circuit breakers, current limiters, bonding and discharge of static • Logic gates, electrostatic devices handling and protection • Engine starter motors	

5.4.21. Aircraft instrument systems

- Pitot static system: function, layout, testing, airspeed indicators, pressure altimeters, and vertical speed indicators
- Gyroscopic components: principles, turn and slip indicators, directional gyros, artificial horizons, and turn coordinators
- Precautions when handling gyroscopic instruments
- Engine instruments: manifold pressure gauge, oil pressure gauge, electrical and mechanical tachometers
- Electrical resistance thermometers, thermocouples, radiometer and torque meters
- Flow measuring instruments: pressure/volume, fuel and mass airflow, sensing type, fuel quantity indicator capacitive and float types
- Compasses: principles and function of magnetic compasses, standby and remote reading
- Effect of faults in components of the aircraft/engine instrument system

5.4.22. Float planes, amphibians and flying boats

- Floats: design, construction, material, corrosion protection, draining and plugs
- Hull: shape, step, planing and strakes
- Water rudders: design, construction, and control
- Mooring, fittings and mooring points, tie down points, anchors and life jackets
- Taxiing, manoeuvre and control of aircraft on water
- Docking and slipping

6. Powerplants:

6.3. Piston Engine:

6.3.1. Principles of operation and terminology

- Understanding of the following terms:
  - bore
  - stroke
  - top dead centre (TDC)
  - bottom dead centre (BDC)
  - swept volume
  - clearance volume
- Calculation of mechanical and thermal efficiency
- Four-stroke operating cycle: efficiency, volumetric efficiency, piston displacement and compression ratio
- Two-stroke operating cycle: piston displacement and compression ratio
- Valve operating cycle: valve lead, valve lag and valve overlap
- Layout and typical firing order of in-line, horizontally opposed, vee and radial piston engines

6.3.2. Engine construction: Top end

- Constructional features, function, classification and material composition of: cylinders, pistons, piston rings, piston or dudgeon pins, connecting rods, inlet and exhaust manifolds

6.4. Propellers:

6.4.1. Propeller theory

- Blade element theory
- Effects on propeller thrust by high/low blade angle and reverse angle, angle of attack, pitch, and rotational speed
- Understanding of propeller slip
- Forces affecting rotating propeller blade: aerodynamic force, centrifugal force, torque and thrust
- Effects in changes in the direction of relative airflow on blade angle of attack

6.4.2. Propeller configuration and type

- Propeller types: fixed pitch, ground adjustable, controllable pitch, and constant speeding

6.5. Turbine Engine:

6.5.1. Fundamental principles

- Relationship between force, work, power, energy, velocity, and acceleration and their respective relationship to gas turbine operation
- Operation and function of the following pitch change mechanisms: mechanical, hydraulic, aerodynamic, aerodynamic and hydraulic combination, and electrical
- Function and operation of propeller feathering and synchronizer systems

6.5.2. Governors: Principles of operation and construction

- Operation of typical governors
- Effects of variation in spring pressure and engine RPM on governor operation
- Single and double acting governors
- Operation and function of speeder springs, pitch change stops, pilot valves, and fly weights
- Understanding of the following conditions on speed:

		• under speed • over speed • alpha • beta • feathering • unfeathering • reverse pitch
6.3.3. Engine construction: Valves and valve operating mechanisms • Constructional features, function, classification and material composition of: rocker assemblies, push rods, cam followers, tappets, inlet and exhaust valves/seats/ guides/springs • Valve types: poppet, sleeve, rotary, disc and reed	**6.4.3. Propeller construction, assembly and installation** • Construction methods and specific materials used in composite, metal and wooden propellers • Typical mounting requirements for tapered and splined propeller installations • Understanding of the following terms: • blade station • blade face • blade shank • blade back • blade shank • hub assembly	**6.5.3. Damage and repair criteria** • Assessment of propeller blade damage • Erosion, corrosion, impact damage and delamination • Treatment/repair schemes for metal, wooden and composite blades • Definition and application to gas turbine operation of the following: • potential energy • kinetic energy • Newton's Laws of Motion • Brayton Cycle • Bernoulli's Theorem • thermodynamic laws • Constant pressure gas turbine cycle, open cycle and closed cycle gas turbines • Basic constructional arrangement and the relative merits of the following engine types: turbojet, turbofan, turboshaft, turboprop, prop fan and ducted fan
6.3.4. Engine construction: Bottom end • Constructional features, function, classification and material composition of: crankshafts, cam shafts, cam rings, engine casings, sumps, and accessory/reduction gearboxes • Typical ball, roller and plain bearings	**6.4.4. Pitch change mechanisms** • Operation and function of the following pitch change mechanisms: mechanical, hydraulic, aerodynamic, aerodynamic and hydraulic combination, and electrical • Function and operation of propeller feathering and synchronizer systems	**6.5.4. Principles of propulsion** • Understanding of the following conditions, their relationship to each other and their application to engine operation: • gross thrust • net thrust • chocked nozzle thrust • thrust distribution • resultant thrust • thrust horsepower • equivalent shaft horsepower • specific fuel consumption • Adiabatic, thermal and propulsive engine efficiencies and ways to derive them • Bypass ratio and engine pressure ratio • Pressure, temperature and velocity of the gas flow as it passes through each section of the engine
6.3.5. Engine power • Calculation of mechanical efficiency, thermal efficiency, volumetric efficiency, piston displacement and compression ratio from given information		**6.5.5. Inlet ducts** • Principles of operation and construction of the following compressor inlet ducts: subsonic, supersonic and bell-mouth • Effects on pressure, velocity and

• Effect of incorrect valve timing on the above parameters • Measurement of piston displacement, compression ratio and manifold pressure		temperature of airflow through convergent, divergent and convergent- divergent ducts • Effects of ram recovery and the causes of inlet duct losses
6.3.6. Engine power measurement • Determination/calculation of horsepower (HP) and/or kilowatt (KW); indicated horsepower (IHP); friction horsepower (FHP); brake horsepower (BHP); indicated mean effective pressure (IMEP); brake mean effective pressure (BMEP); friction mean effective pressure (FMEP) • Plot of fuel consumption and engine power charts from given information		**6.5.6. Centrifugal compressors** • Constructional features, materials, operating principles and applications of single stage and multi-stage centrifugal compressors • Purpose and function of impellers, diffusers, and inlet guide vanes • Pressure ratios, inspection and balancing

6.3.7. Factors affecting engine power
• Rich and lean mixture burn rates and effect upon engine
• Symptoms and causes of: pre-ignition, detonation, after firing and backfiring
• Calculation of brake-specific fuel consumption (BSFC) from given engine data
• Definition of the following terms:
  • stoichiometric mixture
  • rich best power mixture
  • lean best power mixture
  • cruise power mixture
		6.5.7. Axial compressors
		• Constructional features, materials, operating principles and applications of the following axial flow compressors: single spool, dual/twin spool and triple spool
		• Purpose and function of rotor blades, stator blades, fixed inlet guide vanes and variable inlet guide vanes

6.3.8. Classification of engine lubricants and fuels • Properties and specific uses of mineral, ashless dispersant, detergent and hypoid oils • Terms in relation to engine oil ratings: viscosity and viscosity index, flashpoint, pour point and cloud point • Classification methods of piston engine fuels (aviation gasolines) • Terms in relation to piston engine fuels: octane rating, anti-knock additive (tetraethyl lead), performance number, volatility, specific gravity, and Reid vapour pressure test values • Grease: types, characteristics and uses		6.5.8. Compressor operation • Purpose, constructional features, materials, operating principles, advantages and disadvantages of a combined axial and centrifugal compressor assembly • Causes, effects and control of compressor stall and surge • Principal methods of air flow control: bleed valves, variable inlet guide vanes, variable stator vanes and rotating stator blades • Compressor ratio and ways to derive it
6.3.9. Magneto ignition system principles • Magneto principles • Terms: "E" gap, flux eddies, flux reversal, etc. • Function of contact breaker and condenser/capacitor distributor		**6.5.9. Combustion section** • Constructional features, materials and principles of operation of the following combustion chambers and their respective advantages and disadvantages: can type, can-annular type, annular type and

• Primary and secondary systems		reverse flow annular type
		• Understanding of the following terms:
		  • primary zone/airflow
		  • secondary zone/airflow (dilution and cooling)
		  • combustion fuel/air ratio
		  • overall fuel/air ratio
		  • flame temperatures
		  • flame stabilization
		• Construction, purpose and principles of simplex (single orifice) atomizing fuel nozzles, duplex (dual orifices) atomizing fuel nozzles, spill type atomizing fuel nozzles, and vaporising type nozzles
		• Construction, purpose and operation of swirl chambers, air shrouds and discharge orifices

6.3.10. Ignition systems • Construction of polar inductor and rotating magnet magneto types • Effect on timing of magneto points gapping • Advanced and retarded ignition timing • Magneto switches, harnesses, screening and bonding • Construction and function of magneto compensating cam • Battery ignition systems • Auxiliary ignition systems, booster coil, induction vibrator and impulse coupling • Low and high tension systems		**6.5.10. Turbine section** • Principles of operation and characteristics of the following turbine blading: impulse, reaction and impulse-reaction • Purpose and function of nozzle guide vanes and driving force for impulse and impulse reaction turbines • Differences between turbine power extraction requirements for turbojet, turbofan and turboprop engines • Various methods of turbine blade to disc attachment • Causes and effects of turbine blade stress • Factors which determine blade creep • Constructional properties of typical materials used in the fabrication of turbine components
6.3.11. Spark plugs and ignition leads • Constructional features and materials, temperature classification, reach, gapping and effect on spark plug performance • Diagnosis of engine condition by spark plug appearance • Ignition lead/harness construction, features and screening		**6.5.11 Exhaust section** • Constructional features, purpose, operating principles and materials of exhaust system: cone, tailpipe, propelling nozzle, cooling shroud, and gas flow straighteners • Purposes of convergent, divergent and variable area nozzles • Pressure, velocity and temperature changes that occur in various types of exhaust systems • Principles of operation, constructional features and purpose of thrust reversers • Effect of thrust reversers on engine efficiency, re-ingestion of

		exhaust gases, and magnitude of reverse thrust produced • Constructional features, materials and principles of operation of engine noise suppressors • Methods of reducing engine noise level • Relationship between turbulence and energy in the exhaust gas stream to engine noise levels, typical noise patterns and methods of reducing noise levels
6.3.12. Float chamber carburettors • Principles, features and construction • Configurations, updraught and downdraught • Operation of: throttle valves, main and idle jets, power enrichment systems, float chambers, discharge nozzles, accelerator pumps, mixture control systems, and altitude control • Causes and effects of impact, throttle and fuel ice • Carburettors heat		**6.5.12. Bearings and seals** • Types, constructional features and principles of operation of bearings used in gas turbine engines • Primary loads and causes acting on the engine main bearings • Purpose, construction and principles of operation of typical gas turbine engine bearing seals
6.3.13. Pressure injection carburettors • Principles, features and construction • Operation of air/fuel metering forces, mixture control system, idle system, acceleration system and power enrichment system (manual/airflow)		**6.5.13. Classification and properties of lubricants and fuels** • Basic requirements of a gas turbine lubricant: viscosity and viscosity index • Desirable characteristics of synthetic-based lubricants: low volatility, anti-foaming quality, low lacquers and coke deposit, high flashpoint, and low pour point • Properties of gas turbine fuels: specific gravity, calorific value, vapour pressure, flashpoint, fire hazard, fuel icing, and corrosion characteristics • Fuel additives: anti-icing and anti-microbiological • Ground handling requirements and safety precautions to be observed in relation to gas turbine engine fuels, oils and additives • Effects of the following on safety, handling and inspection procedures: exposure to skin or eyes, flammability, misting, evaporation rate, gum formation, corrosion, contamination (water and dirt), and sampling
6.3.14. Fuel injection systems • Principles, features and construction		**6.5.14. Lubrication systems** • Arrangement, requirements and principles of operation of gas

• Operation and function of air/fuel metering forces, impact tubes, venturis, flow dividers, throttle valves, altitude mixture controls, fuel injection nozzles, fuel injection pumps, fuel control units, and electronic control		turbine engine lubrication system • Function, relationship and typical location of oil tank; oil pumps (pressure/scavenge); oil filters/screens; oil jets; oil cooler; scavenge sub-system; vent sub-system (air/oil separators); valves (bypass/check/relief)
6.3.15. Lubrication systems • Principles, features, operation and construction of wet and dry sump lubrication systems • Operation, features and construction of pressure pumps, scavenge pumps, oil coolers, oil cooler regulators, oil tank/hoppers, relief valves, check valves, oil filters, and oil dilution systems • Oil pressure regulation and indication		**6.5.15. Fuel control and metering systems** • Requirements, arrangement and principles of operation of gas turbine fuel control and metering system including: starting control, acceleration scheduling, over-speed governing, power limiting, temperature limiting, air density/altitude/outside air temperature (OAT)/airspeed compensation, and shutdown control • Operation and function of fuel system components: main fuel pumps, fuel filters (HP and LP), fuel heater, fuel control unit (hydro-pneumatic, hydro mechanical and electromechanical), governors and limiting devices, engine sensing variables, and valves (throttle/dump/ shut off)
6.3.16. Induction, exhaust and cooling systems **Construction** and operation of typical engine induction/ intake and alternate air systems • Construction, features, material and operation of typical engine exhaust systems • Engine cooling: air and liquid, and cooling efficiency • Radiators, liquid jackets, pipes and connections • Coolant fluids: types, characteristics and hazards • Heat exchangers, fins, baffles, cowls, cowl flaps, gills, panels, and air seals		**6.5.16. Engine air systems** • Requirements, arrangements and principles of operation of gas turbine engine air distribution and anti-ice control systems (including internal cooling, sealing and external air services) • Relationship, location and operation of engine internal cooling/sealing system components, air distribution/ external services components, and air starting system components • Effects of faults in components on internal cooling/ sealing, anti-icing, anti-surge, bleed and air distribution systems
6.3.17. Supercharging/Turbocharging • Principles and purpose of supercharging and its effects on charge density and temperature; brake horsepower (BHP); manifold absolute pressure (MAP); detonation; revolutions per minute (RPM); fuel consumption		**6.5.17. Starting and ignition systems** • Requirements, arrangements and principles of operation of gas turbine engine starter systems and their components: electric starters, starter generators, air turbine starters, turbo starter systems (cartridge and mono-fuel), and pressure regulating and shut-off

• Construction and operation of typical geared super- charger
• Construction and function of impeller; diffuser; engine gear drives; turbine; intercooler
• Understanding of the following terms:
  • rated altitude
  • critical altitude
  • overshoot
  • boot strapping
  • upper deck pressure
  • manifold pressure
• System configurations: internal (supercharger), external (turbo supercharger), multi-stage and multi-speed
• Differences between ground and altitude boosted engines
		valves
		• Requirements, arrangements and principles of operation of the following engine ignition systems and their components: low voltage D.C. input, high voltage AC input, igniter and glow plug types, and harnesses
		• Safety precautions during servicing and maintenance of engine ignition systems
		• Effect of faults in components of engine ignition and starting systems

6.3.18. Rotary (Wankel) engine theory • Analysis of Wankel (rotary) cycle • Rotor design and shape: rotor tip seals • Combustion chamber shape and sealing • Rotor shaft and epitrochoidal gear drive to output shaft • Unit construction, weight, power, and fuel consumption • Lubrication system • Carburation and control system adjustments		**6.5.18. Power augmentation systems** • Principles of operation, requirements and typical location of components in water injection and water/ methanol injection systems • Interrelationship between the augmentation system components and the fuel control system • Principles of operation and typical location of components in a reheat/afterburner system: burner ring, variable propulsion nozzle/two-position propulsion nozzle, burner ignition (spark, hotshot and catalytic), jet pipe, cooling/airflow, and heat shield • Effects of faults in engine power augmentation systems
6.3.19. Piston engine installation • Safety precautions associated with the installation and removal of engines • Storage, preservation and inhibiting techniques required for piston engines • Engine bearers, anti-vibration mounts, and bearer mounting points • Hoses, pipes, feeders and connections from systems to engine • Control lines and cable lifting points • Inspection of engine bearers for serviceability and condition • Cowls, drains, electrical wiring, exhaust and inlets associated with engine installations		**6.5.19. Engine controls** • Principles of operation, requirements and typical location of components of the following engine controls: linkages and controls to and from propeller coordinator/interconnector and fuel control unit; units and components interconnected for emergency shut- down; mechanical control inputs and outputs for electrical fuel control systems; throttle/power/condition levers, cables and linkages • Effects and rectification of faults in engine controls • Electronic engine control (digital and analogue) including Full Authority Digital Engine Control (FADEC)

6.3.120. Piston engine operation, maintenance and ground running • Precautions and pre-start checks prior to ground running a piston engine • General precautions for starting, running and stopping a piston engine • Use of power charts and graphs to determine engine performance • Determination of piston engine defects from data obtained during an engine run • Maintenance procedures: removal, replacement and inspection of valve operating assemblies, cylinders, pistons, bearings and associated components • Top-end overhauls • Understanding of the use of maintenance data in Specification 100 or 2100 of the Air Transport Association (of America) (ATA)		**6.5.20. Engine operation, maintenance, and ground running** • Precautions and pre-start checks prior to ground running a gas turbine engine • General procedures for starting, ground run-up and stopping a gas turbine engine • Determination of engine and system malfunctions by using given typical manufacturers' data • Interpretation of engine power output and parameters from limitation/performance charts • Principles of trend monitoring pertaining to engine condition • Determination of engine condition/defects from obtained data • Inspection of engine and components according to criteria, tolerances and data specified by engine manufacturer • Hot section inspections and manufacturer designated module split inspections • Compressor washing/soft blasting
6.6 Fuel Systems: Required Knowledge, Skills and Attitudes **6.6.1 Operation, control, construction and indication** • Fuel boost pumps, engine high-pressure pumps and fuel heaters • Refuel/de-fuel, feed, jettison and cross-feed systems • Fuel valve operation and control		**6.5.21. Engine installation, storage and preservation** • Function, construction and configuration of typical gas turbine engine firewalls; cowlings; acoustic panels; engine mountings; anti-vibration mounts; hoses; pipes; feeders; connectors; wiring looms; control cables and rods; lifting points and drains • Blade containment areas/rings • Basic requirements for the preservation and de- preservation of gas turbine engines, accessories and systems (both installed (on the wing) and during storage)
		6.5.22. Turboprop engines • Gas-coupled and gear-coupled turbines • Reduction gears: construction, function and layout • Over-speed safety devices • Propellers for turboprops: design factor, starting requirements, constant speeding, feathering and braking control systems

5.6. Airship Systems and Structures (Elective)	
5.6.1. Principles of lift • Bodies immersed in fluids • Gases: expansion, constant volume, constant pressure and constant temperature • Mixture of gases in a containing vessel • Centre of gravity, centre of buoyancy, static heaviness, static lightness and static trim • Ballonet ceiling and pressure height • Super pressure and superheat • Porosity • Equilibrium and ballast-shot/water	**5.6.7. Heating and ventilation** • Exhaust heat exchangers • Ventilation systems
5.6.2. Theory of flight and control • Aerodynamic lift and aerodynamic balance • Stability and control • Free ballooning, fins, rudders and elevators • Tabs: balance, servo, trim and spring • Powered-flying controls	**5.6.8. Vacuum and pressure** • Supply and associated systems
5.6.3. Envelope • Materials: fabrics and Kevlar • Ultraviolet light effects • Gas-tight membranes • Ballonets, gases load curtains, shear curtains, support cables, gas valves, air valves, entry ports, inspection domes, charge adaptors, load patches, handling lines, and nose cone • Charging, purging, and porosity checks • Lightning protection • Air systems: ram air scoops, ballonet fans, dampers, and transfer fans	**5.6.9. Toilets and water systems** • Toilets • Potable water systems • Potable water: health considerations
5.6.4. Gondola • Materials: Kevlar laminate, Fibrelam sandwich panels, etc. • Moulding/bonding techniques • Support cables, support cable attachments, bulkheads, and equipment attachment • Furnishings • Doors, windows and hatches • Fire protection and skinning • Lightning protection	**5.6.10. Landing gear** • Geometric arrangements • Structural arrangements • Castoring, pivoting and locking • Shock absorbers • Weight sensing/measurement
5.6.5. Airship flight control • Fins, rudder and elevators • Operating systems and surfaces: manual- and power- operated • Trim operating systems: manual and electric	**5.6.11. Airship ducted propellers** • Principles of operation • Propeller forces: aerodynamic and centrifugal • Pitch variation/control • Positive/negative vectoring • Power conversion • Control systems: electronic control and emergency forward course selection • Balance • Clutches • Materials of construction • Protective finishes, contour control, and visibility • Duct pivoting system: drive and control, motors, limit control, gearboxes, interconnection, and emergency manual
5.6.6. Ice and rain protection • Windscreen wipers	**5.6.12. Ground handling** • Attachment to/release from mast

• Surface de-icing systems	• Ground power • Fuelling • Ballasting • Helium: charging, purifying, and leak testing • Pressure watch techniques • Mooring: mobile/portable • Engine running • Hangaring • Adverse weather considerations